

# Using FPGAs to create a complete computer system

Marcela Melara

Hobart and William Smith Colleges '12

9 April 2011

# Overview of the project

- Computer Architecture project
- Project goal: create complete system for classroom
- Used FPGAs to implement processor for the computer

# Major tasks

1. Design and program basic processor (Larc) with RAM
2. Incorporate support for monitor and keyboard
3. Add support for an operating system (Vireos)
4. Incorporate hard disk to support file system
5. Add support for processes using a timer

# Outline of the Talk

I. Demo

II. FPGAs

III. Complete system

IV. The Larc processor

V. System architecture

# Demo

<http://math.hws.edu/mcorliss/presentations/sigcse11-v1.m4v>

# FPGAs

- FPGA = Field-Programmable Gate Array
- Flexibly programmable soft-processor
- Used to build reconfigurable digital circuits → undefined function at time of manufacture
- Configuration specified by hardware description language
  - Used Verilog HDL in my project

# The Altera Cyclone II DE1 board

- Hardware components:
  - Processor
  - Memory (RAM)
  - I/O devices
  - Hard disk

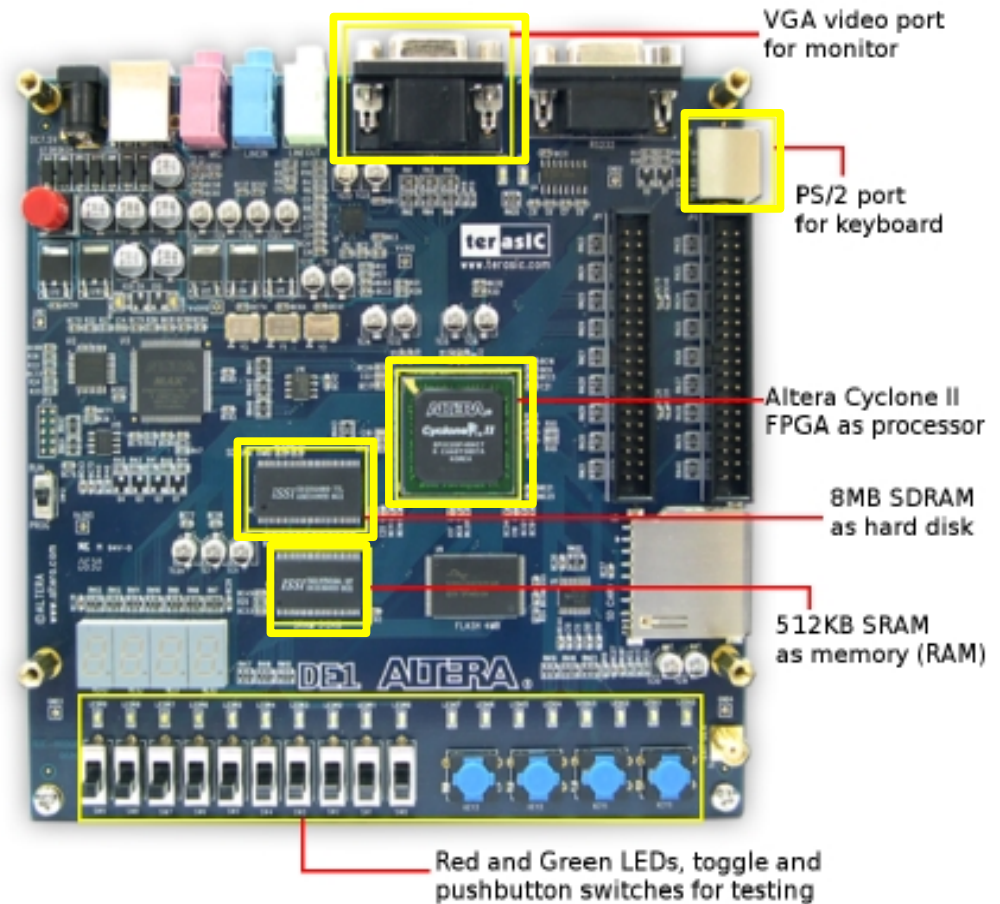


Fig. 1 Altera DE1 Board Overview; components used in the project are marked

# Complete system

- All components are connected via a high-speed bus

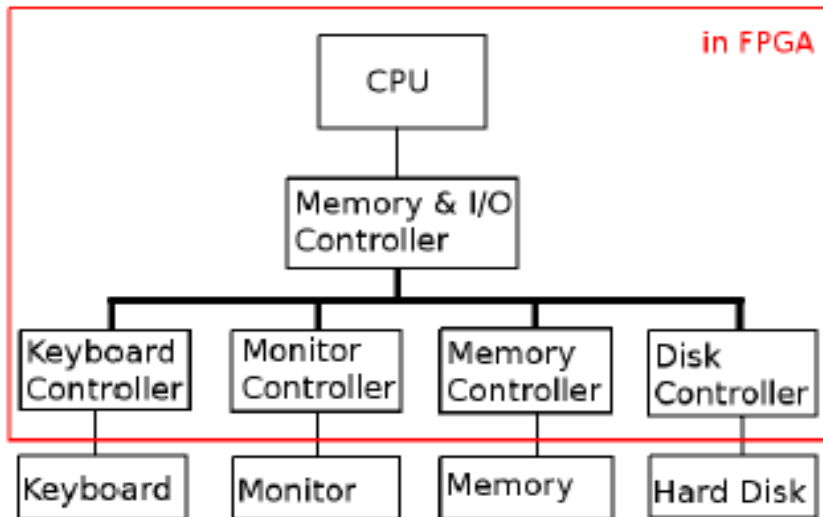


Fig. 2 Broad overview of the Larc processor



Fig. 3 The complete computer system



# The Larc processor

- Processor width: 16 bits
- 16 registers → register file
- 16 instructions:
  - 8 logical/arithmetic operations
  - 2 memory-reference
  - 2 conditional branches



# The System Architecture

- Use an OS called Vireos: simple OS, that is specifically made to run on Larc processor
- Support for OS via the implementation of a system call instruction
  - User applications communicate with the OS via this instruction
  - Request instruction from user program to OS to perform a lower-level task

# Input/Output

- OS communicates with I/O devices through memory-mapped registers
- Use polling to check status of I/O devices in these registers

# File and Process Support

- Added support for hard disk → file system!
- User can work with files and directories through incorporated Shell program
- Shell has timesharing capabilities to support multiple processes
  - Timer in processor allows for preemptive switching

# Future Work

- Enhance the processor performance
  - Make better use of resources to increase speed of execution cycle
- Add more functionality such as network connectivity
- Create more applications to run on top of OS
- Application-specific processors for use in other scientific fields

# Conclusions

- Built computer system from its most basic hardware components
- Support for simple OS and file system
- FPGAs currently being used in Computer Architecture course